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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. FUJY 14.298A

First Inventor or Application Identifier A. OHY@SHI

Title TRAFFIC CONTROL METHOD, NETWORK SYSTEM...

Express Mail Label No. EL52238483US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
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1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
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2. ☒ Specification [Total Pages: 59]
(preferred arrangement set forth below)
 - Descriptive title of the invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the invention
 - Brief Summary of the invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets: 15]
4. Oath or Declaration [Total Pages: 1]
 - a. ☐ Newly executed (original or copy)
 - b. ☒ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 17 completed)
(Note Box 5 below)
 - i. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).
5. ☒ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. ☐ Microfiche Computer Program (Appendix)
7. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. ☐ Assignment Papers (cover sheet & document(s))
9. ☐ 37 C.F.R. § 3.73(b) Statement (when there is an assignee) ☒ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☒ Information Disclosure Statement (IDS)/PTO-1449 ☒ Copies of IDS Citations
12. ☒ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
 - * Small Entity ☐ Statement filed in prior application, Status still proper and desired
14. ☐ Statement(s) ☐ Status still proper and desired (PTO/SB/09-12)
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
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17. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application No: 08, 863, 500
Prior application information: Examiner QURESHI, A. Group / Art Unit 2738

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	EMPIRE STATE BUILDING, 60TH FLOOR				
Address	350 FIFTH AVENUE				
City	NEW YORK	State	NEW YORK	Zip Code	10118-0110
Country	NEW YORK	Telephone	212-643-5000	Fax	212-643-2166

Name (Print/Type)	Jacqueline M.-Steady	Registration No. (Attorney/Agent)	44,354
Signature	<u>Jacqueline M. Steady</u>	Date	01/10/2000

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ATTORNEY DOCKET NO.: FUJY 14,298 *[Handwritten initials]*

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor: AKITSUGU OHYOSHI et al.

Serial No.:

Filed:

Title: **TRAFFIC CONTROL METHOD, NETWORK SYSTEM
AND FRAME RELAY SWITCH**

Examiner:

Group Art Unit:

January 10, 2000

Assistant Commissioner for Patents
Washington, D. C. 20231

PRELIMINARY AMENDMENT

S I R :

IN THE CLAIMS:

Please amend the claims as follows:

Kindly cancel claims 13-18 without prejudice.

1.(amended) A traffic control method in a network system comprising an ATM
(Asynchronous Transfer Mode) network, plural frame relay networks respectively

connected to the ATM network through channels and plural terminals respectively connected to the plural frame relay networks through channels, said traffic control method comprising steps of:

[a step of] measuring a data quantity transmitted through each channel;

[a step of] operating a traffic restrictive level corresponding to the data quantity of each channel which is measured, per channel, wherein the traffic restrictive level is a level to prevent excess of contract cell rate of the ATM network and has a plurality of levels; and

[a step of] performing a traffic restrictive process corresponding to a level of the traffic restrictive level which is operated about each channel.

9.(amended) A network system comprising:

an ATM (Asynchronous Transfer Mode) network;

plural frame relay networks respectively connected to the ATM network through channels;

plural terminals respectively connected to the plural frame relay networks through channels;

a data quantity measurement [means for] portion measuring a data quantity transmitted through each channel;

a restrictive level operation [means for] portion operating a traffic restrictive level corresponding to the data quantity of each channel measured by said data quantity measurement [means] portion, per channel, wherein the traffic restrictive level is a level to prevent excess of contract cell rate of the ATM network and has a plurality of levels; and

a traffic control [means for] portion performing a traffic restrictive process corresponding to a level of the traffic restriction level operated about each channel by said restrictive level operation [means] portion.

10.(amended) A network system comprising:

an ATM (Asynchronous Transfer Mode) network;

plural frame relay networks respectively connected to the ATM network through channels;

plural terminals respectively connected to the plural frame relay networks through channels;

a data quantity measurement [means for] portion measuring a data quantity transmitted through each channel;

a restrictive level operation [means for] portion operating a traffic restrictive level corresponding to the data quantity of each channel measured by said data quantity measurement [means] portion, per channel, wherein the traffic restrictive level is a level to prevent excess of contract cell rate of the ATM network and has a plurality of levels;

a restrictive process storage [means for] portion storing information of a traffic restrictive process corresponding to a level of the traffic restrictive level operated by said restrictive level operation [means] portion about each channel; and

a traffic control [means for] portion reading out the information of the traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation [means] portion about each channel from said restrictive process storage [means] portion and [for] performing the traffic restrictive process corresponding to the information read out from said restrictive process storage [means] portion to each channel.

11.(amended) A network system according to claim [the one of the claims 9 and] 10, wherein at least one of the plural terminals is connected to the ATM network through no frame relay network.

12.(amended) A frame relay switch in plural frame relay networks in a network system comprising an ATM (Asynchronous Transfer Mode) network, said plural frame relay networks respectively connected to the ATM network through channels and provided with plural frame relay switch, and plural terminals respectively connected to the plural frame relay networks through channels, said frame relay switch comprising:

a data quantity measurement [means for] portion measuring a data quantity transmitted through each channel;

a restrictive level operation [means for] portion operating a traffic restrictive level corresponding to the data quantity of each channel measured by said data quantity measurement [means] portion, per channel, wherein the traffic restrictive level is a level to prevent excess of contract cell rate of the ATM network and has a plurality of levels;

a restrictive process storage [means for] portion storing information of a traffic restrictive process corresponding to a level of the traffic restrictive process corresponding to a level of the traffic restrictive level operated by said restrictive level operation [means] portion about each channel; and

a traffic control [means for] portion reading out the information of the traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation [means] portion about each channel and performing the traffic restrictive [process] processes corresponding to the information read out from said restrictive process storage [means] portion to each channel.

REMARKS

Claims 1-12 are pending in the present application.

The present invention recited in independent claims 1, 9, 10, and 12 teach that transmission traffic flowing toward an ATM network is measured in a frame relay network and traffic is controlled using identifiers of FECN, BECN and DE defining a header of a frame relay which gradually executes commands based on the traffic restrictive level corresponding to condition of the transmission.

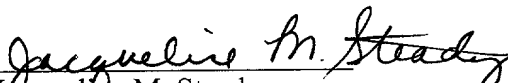
Bustini et al., however, disclose a method of traffic control based on rate control in an ATM switch. This method prevents cells transmitted to a destination ATM network or a destination ATM switch from exceeding a contract cell rate. This method is applied technology of a scheduler of a ATM switch, generally known.

As discussed in the response filed on May 24, 1999, the controlling of the contract cell rate of Bustini et al. is in a different electrical location than the traffic restrictive levels of the present invention. In addition, Bustini et al. fail to teach a frame relay network, thus, no combination of Bustini et al. and Osaki could operatively arrive at the presently claimed invention. Moreover, the benefit of the present invention is to allow data quantity to be controlled within a desired range in a channel. The "frame relay networks" in combination with the traffic restrictive level having a plurality of levels allows the present invention to control congestion, discard data, and transmit messages at a maximum transmission rate for each channel. As discussed above, Bustini et al. are physically incapable of achieving this benefit.

Accordingly, as the cited art either individually or in combination fails to teach or suggest the claimed invention, it is respectfully requested that the Examiner withdraw all rejections under 35 U.S.C. §103(a).

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Respectfully submitted,


Jacqueline M. Steady
Reg. No. 44,354

HELFGOTT & KARAS, P.C.
EMPIRE STATE BUILDING
60TH FLOOR
NEW YORK, NEW YORK 10118
(212) 643-5000
DOCKET: FUJY 14.298
SH:JMS:1hda:FUJY14298-2

TRAFFIC CONTROL METHOD, NETWORK SYSTEM

AND FRAME RELAY SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 The present invention relates to a network system
in which plural frame relay networks are connected to an
ATM (Asynchronous Transfer Mode) switch, to a traffic
control method in the network system and to a frame
relay switch in each of the plural frame relay networks.

10 2. Description of the Related Art

Recently, the B-ISDN (Broadband Integrated Service
Digital Network) is rapidly introduced as the LAN (Local
Area Network) is made a high speed and a multimedia. In
data communication, as a first step for the next
15 generation, cases increase in that an ATM network is
used as a repeater for frame relay networks.

FIG. 16 is a whole structural view of a network
system which an ATM network is used as a repeating
network for plural frame relay networks. In FIG. 16,
20 frame relay networks 1, 2 are respectively connected
with an ATM network 3 through each IWF (InterWork
Function) 4 which disassembles a frame into cells. The
frame relay networks 1, 2 are also respectively
connected with terminals 5, 6 for users in the network
25 system. In the ATM network, a VP (Virtual Path) which
plural VCs (Virtual Channel) are put together is set,
and communication channels (VCC: Virtual Channel

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increase in the frame relay networks FR1, FR2. Thus,
there was a possibility in that a response deteriorates
between the terminal 5 and the terminal 6 (end to end).

SUMMARY OF THE INVENTION

5 Accordingly, it is an object of the present
invention to solve the above described problems, and to
provides a traffic control method, a network system and
a frame relay switch, wherein it is possible to prevent
a number of cells in an ATM network from exceeding a
10 maximum transmission rate (PCR).

 The present invention introduces the following
structure to solve the above described problems.

 That is, the preset invention relates to a traffic
control method in a network system. The network system
15 comprises an ATM (Asynchronous Transfer Mode) network,
plural frame relay networks respectively connected to
the ATM network through channels and plural terminals
respectively connected to the plural frame relay
networks through channels. In this traffic control
20 method, a data quantity transmitted through each channel
is measured, a traffic restrictive level corresponding
to the data quantity which is measured is operated, and
a traffic restrictive process corresponding to the
traffic restrictive level which is operated is performed
25 (first aspect).

 According to the traffic control method in the

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present invention, for example, when data is transmitted from the frame relay network to the ATM network, a data quantity is measured in the frame relay network connected with the transmitted terminal of the data, the traffic restrict level is operated in accordance with this data quantity, and the traffic restrict process is performed. Thus, the data quantity can be controlled within a desired range.

The data quantity may be measured when the frame relay network transmits a frame or receives a frame.

Any number of steps (levels) may also set as the traffic restrictive level when necessary. The measuring time of the data quantity can be varied suitably, namely, may be fixed or may be varied in accordance with the congestion condition in the network system.

The traffic restrictive process may comprise a process for writing information indicating that a congestion occurs to data transmitted through the each channel (fourth aspect). For example, "1" is set into a FECN (Forward Explicit Notification-bit) stored in a core header of the frame to be data, the transmitted terminal of the frame receives the frame of which the FECN stored in the core header, whereby a congestion control is performed (such as the frame transmission to the frame relay network is controlled or stopped). "1" is set into a BECN (Backward Explicit Notification-bit) stored in a core header of the frame to be data, the

transmitted terminal of the frame receives the frame of which the FECN stored in the core header, whereby a congestion control is performed.

The traffic restrictive process may comprise a
5 process for discarding data transmitted through the each
channel.(fifth aspect).

The traffic restrictive process may comprise a process for transmitting a message indicating that a congestion occurs to a transmitting terminal of data transmitted through the each channel (sixth). For example, a CLLM (Consolidated Link Layer Management) message is transmitted to the transmitting terminal of the frame to be data, the transmitting terminal of the frame receives the CLLM message, whereby a congestion control is performed.

One of the above-mentioned traffic restrictive processes may be performed, and the plural traffic restrictive processes may be also performed synchronously. The correspondence between the traffic restrictive level and the traffic restrictive process can be set suitably.

The traffic restrictive process may be performed based on a maximum transmission rate set for the each channel (seventh aspect).

25 In the traffic control method of the present invention, the data quantity may be measured as to data transmitted from each of the plural frame relay networks

to the ATM network through the each channel (second aspect).

In the traffic control method, a traffic restrictive class set for the each channel may be detected, and the traffic restrictive process corresponding to the traffic restrictive class which is detected may be performed. In this case, the traffic restrictive process can be performed in accordance with the importance of the channel, therefore, channels can be discriminated. Any number of channels can be available, and the channels include a physical channel, a virtual channel, a logical channel (data links) and so on. The traffic restrictive classes can be set at any number of steps.

At least one of the plural terminals may be connected to the ATM network through no frame relay network (eighth aspect).

The present invention also relates to a network system comprising an ATM (Asynchronous Transfer Mode) network, plural frame relay networks respectively connected to the ATM network through channels, plural terminals respectively connected to the plural frame relay networks through channels, a data quantity measurement unit for measuring a data quantity transmitted through each channel, a restrictive level operation unit for operating a traffic restrictive level corresponding to the data quantity measured by the data

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the traffic restrictive process corresponding to the traffic restrictive level operated by the restrictive level operation unit and performing the traffic restrictive process read from the restrictive process storage unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent during the following discussion conjunction with the accompanying drawings, in which:

FIG. 1 is a whole structural view of a network system according to an embodiment of the preset invention;

FIG. 2 is an explanatory view of channels in the network system shown in FIG. 1;

FIGs. 3(a) and 3(b) are structural views of a frame and a cell;

FIG. 4 is a circuit structural view of a frame relay switch shown in FIG. 1;

FIG. 5 is a block diagram illustrating functions implemented by performing a control program in the frame relay switch shown in FIG. 4;

FIG. 6 is a structural view of a restrictive class management table shown in FIG. 5;

FIG. 7 is a structural view of a restrictive threshold management table shown in FIG. 5;

FIG. 8 is a structural view of a transmission data cumulative table shown in FIG. 5;

FIG. 9 is a structural view of a transmitted frame relay network number retrieval table shown in FIG. 5;

5 FIG. 10 is a structural view of a task number
storage table shown in FIG. 5;

FIG. 11 is a flow chart illustrating a process by a frame relay switch shown in FIG. 1;

FIG. 12 is a flow chart illustrating a process by a
10 frame relay switch shown in FIG. 1;

FIG. 13 is a flow chart illustrating a process by a frame relay switch shown in FIG. 1;

FIG. 14 is a flow chart illustrating a process by a frame relay switch shown in FIG. 1;

FIG. 15 is a sequence diagram illustrating an operational sample of the network system shown in FIG. 1;

FIG. 16 is a whole structural view of the network system shown in FIG. 1; and

FIG. 17 is a view for explaining an outline of a traffic restrictive process in the network system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Detailed explanations will be given of a traffic control method, a network system and a frame relay switch according to the present invention based on a preferred embodiment shown in drawings.

First, an explanation will be given of an outline of the network system according to this embodiment with reference to FIGs. 1, 2. FIG. 1 is a whole structural view of the network system according to this embodiment.

5 In FIG. 1, an ATM network 20 is connected with three frame relay networks FR1, FR2, FR3 via IWFs (InterWork Function) 21a-21c, respectively. The frame relay networks FR1, FR2, FR3 are respectively connected with plural frame relay terminals (hereinafter, simply called
10 "terminal") 22a-22h.

The ATM network 20 is provided with plural ATM switches (VCH, VPH) not shown and repeats a frame F (see FIG. 3(a)) between the frame relay networks FR1, FR2, FR3 by using a cell S (see FIG. 3(b)). The IWFs 21a-21c
15 are repeaters for changing a frame F transmitted from one of the frame relay networks FR1-FR3 connected thereto into cells S (see FIG. 3(b)) so as to transmit the cells S to the ATM network 20 and for assembling cells S received from the ATM network 20 into a frame F
20 so as to transmit the frame F to one of the frame relay networks FR1-FR3 connected thereto. The respective frame relay networks FR1-FR3 is provided with plural frame relay switches 31 connected through frame relay circuits (physical channel). The respective terminals 22a-22h are
25 respectively connected with one of the frame relay switches 31a-31f via the frame relay circuits in the respective frame relay networks FR1-FR3. Each terminal

22a-22h, when data is transmitted to another terminal, generates a frame F and transmits it to one of the frame relay switches 31a-31f connected thereto.

FIG. 2 is an explanatory view of channels set in the network system shown in FIG. 1. In FIG. 2, four data links (logical channels) connecting the IWF 21a and the respective terminals 22a-22d are set in the physical channel (frame relay circuit) connecting between the terminals 22a-22d and the IWF 21a. Then, DLCI (Data Link Connection Identifier) numbers a-d are respectively set for the data links (hereinafter, respective data links are called "DLCIa, DLCIb, DLCIc, DLCId"). Similarly, the terminal 22e and the IWF 21b are connected via the data link of the DLCI number e (hereinafter, called "DLCIe"), and the terminal 22f and the IWF 21b are connected via the data link of the DLCI number f (hereinafter, called "DLCIf"). Moreover, the terminal 22g and the IWF 21c are connected via the data link of the DLCI number g (hereinafter, called "DLCIg"), and the terminal 22h and the IWF 21c are connected via the data link of the DLCI number h (hereinafter, called "DLCIh").

In FIG. 2, two VCs (Virtual Channels) are set between the IWF 21a and the ATM network 20, and a not shown VP (Virtual Path) in which these VCs are put together is also set therebetween. A $VCCx_1$ and a $VCCx_2$ which are VCCs (Virtual Channel Connections) of the respective VCs are also set. The $VCCx_1$ is connected with

the DLCIa and the DLCIb, and the VCCx₂ is connected with
the DLCIc and the DLCId. Similarly, a VCCy which is a
VCC of the VC is also set, and is connected with the
DLCIe and the DLCIf. A VCCz which is a VCC of the VC is
5 also set, and is connected with the DLCIg and the DLCIh.
The VCCx₁, the VCCx₂, the VCCy and the VCCz are
connected one another through the ATM network 20. As
above described, a VCC is allocated to each IWF 21a-21c
every transmitted frame relay network (frame relay
10 network connected with a transmitted terminal of a frame
F). Then, every VCC (VCI, VPI) connecting each IWF 21a-
21c and the ATM network 20, a maximum transmission rate
(PCR: Peak Cell Rate) indicating the quantity of the
maximum transmission data which can be transmitted via
15 that VCC is set.

Traffic restrictive class (restrictive class)
indicating importance of each data link is set for each
of DLCIa-DLCIh. The restrictive class is divided into
three stages including a usual class, an important class
20 and a most important class, and one of the classes is
set for each of DLCIa-DLCIh as a restrictive class of a
stage corresponding to the importance of the data link.
Traffic restrictive level (restrictive level) indicating
a traffic restrictive level corresponding to the
25 quantity of data transmitted via each DLCIa-DLCIh
(transmitted data quantity) is set for each of DLCIa-
DLCIh. The restrictive level is divided into five stages

including non-restriction, and first-fourth restrictions in accordance with the transmitted data quantity, and is varied in accordance with the increase and decrease of the transmitted data quantity. In this network system, a traffic restrictive process is performed in accordance with the above mentioned restrictive level and restrictive class in the frame relay networks FR1-FR3.

Next, an explanation will be given of a frame F and a cell S transmitted in this network system with reference to FIGs. 3(a) and 3(b). FIG. 3(a) is an explanatory view showing a format of a frame F transmitted between a terminal and an IWF, and FIG. 3(b) is an explanatory view showing a format of a cell S transmitted among an IWF, an ATM network, and an IWF.

In FIG. 3(a), the frame F is structured based on the ITU-T (International Telecommunication Union-Telecommunication Standardization Sector) recommendation Q. 922. The frame F includes a core header 27 and a data part 28. Further, a head flag 25 is added to the head of the core header 27, and a FCS (Frame Check Sequence) 29 and a tail flag 30 are added to the tail of the data part 28. The core header 27 is the Q. 922DL core header which stores a DLCI (Data Link Connection Identifier) number, a FECN (Forward Explicit Notification-bit), a BECN (Backward Explicit Notification-bit), a DE (Discard Eligibility indicator) and so on. The DLCI number is an identifier to transmit the frame F to a predetermined

terminal (transmitted terminal) by identifying plural data links (logical channels) set in this network system. The frame F is transmitted through the data link having the DLCI number corresponding to the DLCI number stored in itself (the frame F). The FECN is information (bit) for informing that a congestion avoidance procedure is necessary for a transmitted terminal of the frame F. The BECN is information (bit) for informing that a congestion avoidance procedure is necessary for a transmitting terminal of a frame F. The FECN and the BECN are usually set to "0", and, when a congestion occurs, are changed to "1" in the frame relay network (frame relay switch) which the congestion occurs. The DE is information whether the frame F must be discarded in taking priority over another frame or not, and when the DE is "1", the frame is discarded in taking priority. In the data part 28, user communication data of the terminals 22a-22h and the like are stored. In the FCS 29, information for detecting an error of the frame F is stored. Further, the head and tail of the frame F can be recognized by the head flag 25 and the tail flag 30.

In FIG. 3(b), the cell S is provided with a cell header 70 of 5 octet and a data part 71 of 48 octet. In the cell header 70, a VPI (Virtual Path Identifier), a VCI (Virtual Channel Identifier) and the like are stored. The VPI and the VCI are identifiers for selecting a communication path (VCC) for the cell S. The

VPI and the VCI are identified in the IWFs 21a-21c and the ATM network 20, whereby the cell S is transmitted via a suitable communication path (VCC). The data part 71 is an area for storing communication data of the terminals 22a-22h and so on. When a frame F is disassembled into cells S in the IWFs 21a-21c, the core header 28 and the data part 28 of the frame F are divided per 48 octet, each part of divided frame becomes a content of the data part 71 in the cell S. Then, the cell header 40 is added to each part of divided frame, whereby plural cells are formed.

Next, an explanation will be given of an outline of the traffic restrictive process in this network system with reference to FIG. 17.

FIG. 17, in relation to the restrictive classes and the restrictive levels, shows traffic restrictive processes (restrictive tasks) which are preformed on the basis of combinations of the restrictive classes and the restrictive levels. As shown in FIG. 17, for each restrictive level, a condition expression to be that restrictive level is set as follows. Concretely, a condition expression which a restrictive level becomes non-restriction (expression 1), a condition expression which a restrictive level becomes a first restriction (expression 2), a condition expression which a restrictive level becomes a second restriction (expression 3), a condition expression which a

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5      SD≤maxR×t1×n1                                     ...(expression 1)
      maxR×t1×n1<SD≤maxR×t1×n1≤maxR×t1×n2             ...(expression 2)
      maxR×t1×n2<SD≤maxR×t1×n1≤maxR×t1×n3             ...(expression 3)
      maxR×t1×n3<SD≤maxR×t1×n1≤maxR×t1×n4             ...(expression 4)
      maxR×t1×n4<SD                                     ...(expression 5).

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When a restrictive class is the usual class, the following traffic restrictive process is performed in accordance with restrictive levels. That is, when a restrictive level is non-restriction, no traffic restrictive process is performed (process task (1)).

25 accordance with restrictive levels. That is, when a
restrictive level is non-restriction, no traffic
restrictive process is performed (process task (1)).

When a restrictive level is the first restriction, in each frame relay network FR1-FR3, "1" is set into the FECN in the core header 27 (see FIG. 3(a)) of a frame F to be transmitted (process task (2)) and "1" is set into the BECN in the core header 27 of a received frame F (process task (5)). When a restrictive level is the second restriction, in each frame relay network FR1-FR3, when "0" is set in the DE of the core header 27 of a frame F to be transmitted, "1" is set into the FECN of the frame F, and when "1" is set in the DE, the frame F is discarded (process task (3)). The above-mentioned process task (5) is also performed for the received frame F. When a restrictive level is the third restriction, in each frame relay network FR1-FR3, the same traffic restrictive process as the second restriction, namely, the process task (3) and the process task (5) are performed. When a restrictive level is the fourth restriction, in each frame relay network FR1-FR3, the transmitted frame is discarded (process task (4)), and the above-mentioned process task (5) is performed.

Further, when the restrictive class is the important class, the following traffic restrictive process is performed in accordance with the restrictive levels. That is, when a restrictive level is non-restriction or the first restriction, the process task (1) is performed, namely, no traffic restrictive process

is performed. When a restrictive level is the second restriction, in each frame relay network FR1-FR3, the process task (2) and the process task (5) are performed. When a restrictive level is the third restriction, in each frame relay network FR1-FR3, the process task (3) and the process task (5) are performed. When a restrictive level is the fourth restriction, in each frame relay network FR1-FR3, the process task (4) and the process task (5) are performed.

Moreover, when the restrictive class is the most important class, the following traffic restrictive process is performed in accordance with the restrictive levels. That is, when a restrictive level is non-restriction or one of the first-third restrictions, the process task (1) is performed, namely, no traffic restrictive process is performed. When a restrictive level is the fourth restriction, in each frame relay network FR1-FR3, the process task (4) and the process task (5) are performed.

Next, an explanation will be given of frame relay switches 31a-31i in the respective frame relay networks FR1-FR3. FIG. 4 is a sample of a circuit structural view of each frame relay switch 31. Each frame relay switch 31a-31i has the same structure, therefore, the explanation is given by using the frame relay switch 31g as a sample. In FIG. 14, the frame relay switch 31g is provided with a management processor unit 32 and a

circuit dealing unit 41.

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The management processor unit 32 performs the control and the monitor all over the frame relay switch 31, the maintenance and management for various data, the input/output control for commands and messages, the making and the keeping of connection records and the like. The management processor unit 32 is provided with an active CC (Central Controller) 33a, a spare CC 33b, an active MM (Main Memory) 34a connected with the CC 33a via a bus, a spare MM 34b connected with the CC 33b via a bus, an active CHCs (Channel Controller) 35a, 35b respectively connected with the CC 33a via buses, a spare CHCs 35c, 35d respectively connected with the CC 33b via buses, SIAs (Serial Interface Adapter) 36a, 36b and IOCs (disk Input Output Controller) 37a, 37b respectively connected with the CHCs 35a, 35d via buses, a system console 38 connected with the SIA 36a, hard disks 39 respectively connected with the IOCs 37a, 37b, and a MO (Magnetic Optical disk) 40 connected with the IOC 37a.

The hard disk 39 is a medium storing a control program (computer program) for the frame relay switch 31g and data to perform the control program. The respective MMs 34a, 34b are operating areas for the CCs 33a, 33b, and when the CCs 33a, 33b perform the control program stored in the hard disk 39, the control program is loaded to the MMs 34a, 34b. The CCs 33a, 33b perform

the control programs respectively loaded to the MMs 34a, 34b, and send commands to the respective parts in the frame relay switch 31g to perform the operational control for the respective parts.

5 The respective CHCs 35a-35d perform the control of the input output channel (physical channel, logical channel) and the control of the data transfer with the MMs 34a, 34b in accordance with the commands from the respective CCs 33a, 33b. The IOCs 37a, 37b control the
10 operations of the hard disks 39 and the MO 40 in accordance with the commands from the respective CCs 33a, 33b. The MO 40 functions as an external unit of the frame relay switch 31g and performs the loading of the initial program, the drawing up of data and the like.

15 The system console 38 is an interface for outputting data stored in the hard disks 39 and the MO 40, performed results in the CCs 33a, 33b and so on to the outside, and for inputting data, commands and so on from the outside.

20 The circuit dealing unit 41 is a CMU (Communication Multiplexer Unit) accepting plural circuits (physical channel, virtual channel, logical channel). The circuit dealing unit 41 is provided with MPs (line Management Processor) 42 respectively connected with the CHCs 35b,
25 35c via buses, plural pairs of LCs (Line Controller) 43a (active), 43b (spare) respectively connected with the MP 42 via a bus, and plural LSW (Line Switch) 44 connected

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Each LSW 44 accepts plural circuits (physical channel) and receives the frame F transmitted from the outside. Each LSW 44 also transmits the frame F received from the LC 43a or the LC 43b to suitable circuits. At that time, each LSW 44 transmits the frame F to the circuits corresponding to commands from the MP 42. Moreover, the LSW 44 receives the commands from the MP 42 via each LC 43a, 43b, and controls logical, electrical and physical interfaces in accordance with those commands.

The MP 42 manages the line setting in the line
20 dealing unit 41. That is, the MP 42 controls the
communications between the CHCs 35b, 35c and the LCs
43a, 43b, respectively. Concretely, one of each pair of
the LCs 43a, 43b is made in an operating status (active)
and the other is made in a stopping status (spare). The
25 MP 42, when receives a frame F from the active LC 43a,
sends the received frame F to the active CHC 35b. In
this way, the frame F is stored in the active MM 34a,

and then a predetermined process is performed for the frame F. On the contrary, the MP 42, when receives a frame F from the CHC 35b, sends the frame F to the active LC 43a. Moreover, the MP 42 sends a transmitting
5 command that a frame F is transmitted from which circuits accepted in each LSW 44. The transmitting command is sent to the respective LSWs 44 through the LC 43a, 43b.

The frame relay switch 31g structured like this
10 performs the transmitting/receiving process of the frame F in accordance with the ITU-T recommendation Q. 922 and the ITU-T recommendation Q. 933. Concretely, each frame relay switch 31a-31i performs the transmitting
/receiving process of the frame F between the each
15 terminal 22a-22h and each frame relay network FR1-FR3 and between each frame relay network FR1-FR3 and each IWF 21a-21c.

Next, an explanation will be given of functions implemented by loading the control program stored in the
20 hard disk 39 in the frame relay switch 31 to the MMs 34a, 34b and by performing the control program in the CCs 33a, 33b (through the MMs 34a, 34b) with reference to the block diagram shown in FIG. 5. As shown in FIG. 5, the control program is performed in the CCs 33a, 33b,
25 whereby a restrictive class management table 50, a restrictive threshold management table 51, a transmission data cumulative table 52, a transmitted

frame relay network number retrieval table 53, and a task number storage table 54, are made. Further, the control program is performed in the CCs 33a, 33b, whereby a frame transmission processing part 55, a traffic control part 56, a frame reception processing part 57 and a transmission data initializing part 58 are realized.

The restrictive class management table 50 corresponds to restrictive class storage means of the present invention. The task number storage table 54 corresponds to restrictive process storage means of the present invention. The traffic control part 56 corresponds to data quantity measurement means, restrictive level operation means, and traffic control means of the present invention.

FIG. 6 is a structural view of the restrictive class management table 50. In FIG. 6, restrictive class management table 50 is provided with the plural areas which can be retrieved by a transmitted frame relay network number (peculiar number set for each frame relay network FR1-FR3, namely, peculiar number of a frame relay network connected with a transmitted terminal of the frame F). One of the above mentioned restrictive class is stored in each area in relation to the DLCI number corresponding to the transmitted frame relay number. The restrictive class management table 50 can be retrieved by the transmitted frame relay network number

and the DLCI corresponding to the transmitted frame relay network number as retrieval keys.

FIG. 7 is a structural view of the restrictive threshold management table 51. In FIG. 7, values for operating the above-mentioned restrictive levels are stored in the restrictive threshold management table 51 every transmitted frame relay network number. Concretely, the allowable maximum transmission rate (maxR), the measuring time (t1) and the first-fourth restrictive coefficients (n1-n4) are stored in the restrictive threshold management table 51 every transmitted frame relay network number. The restrictive threshold management table 51 can be retrieved by using the transmitted frame relay network number as a retrieval key.

FIG. 8 is a structural view of the transmission data cumulative table 52. In FIG. 8, a cumulative transmission data quantity (SD2) and one of the above mentioned restrictive levels are stored in the transmission data cumulative table 52 every transmitted frame relay network number. The transmission data cumulative table 52 can be retrieved by using the transmitted frame network number as a retrieval key.

FIG. 9 is a structural view of the transmitted frame relay network number retrieval table 53. In FIG. 9, a transmitted frame relay network number is stored in the transmitted frame relay network number retrieval

table 53 every DLCI number. The transmitted frame relay network number retrieval table 53 can be retrieved by using the DLCI number as a retrieval key.

FIG. 10 is a structural view of the task number storage table 54. In FIG. 10, the task number storage table 54 is provided with a transmitting process task storage area 54a and a receiving process task storage area 54b. Each storage area 54a, 54b is divided into three class areas 59 corresponding to the above mentioned three restrictive classes, and the above-mentioned process tasks (1)-(5) are stored in each class area 59 in relation to the restrictive levels. The task number storage table 54 can be retrieved by using process identifier information (transmitting process information (bit "0"), receiving process information (bit "1")) indicating that one of the transmitting process and the receiving process is performed, a restrictive class and a restrictive level as retrieval keys. That is, one of the transmitting process task storage area 54a and the receiving process task storage area 54b is selected by the process identifier information, one of the class areas 59 is selected by a restrictive class, and one of the process tasks (1)-(5) is read by a restrictive level so as to correspond to that restrictive level.

The frame transmission processing part 55 shown in FIG. 5 starts, when a frame F is transmitted from one of

the frame relay networks FR1-FR3 to one of the IWFs 21a-21c. The frame transmission processing part 55 reads the transmitted frame relay network number out from the transmitted frame relay network number retrieval table 53 (see FIG. 9). The traffic control part 56 starts by receiving the transmitted frame relay network number, the DLCI number, and the process identifier information (receiving process information held the frame transmission processing part 55) from the frame transmission processing part 55. The frame transmission processing part 55 receives a notification requiring a discard or a notification requiring no discard of a frame F from the traffic control part 56, determines whether the frame F is discarded or not, and discards the frame F when it is determined that the frame F is discarded.

The frame reception processing part 57 starts when a frame F is received by one of the frame relay networks FR1-FR3 through one of the IWFs 21a-21c. The frame reception processing part 57 reads the transmitted frame relay network number out from the transmitted frame relay network number retrieval table 53 (see FIG. 9). The traffic control part 56 starts by receiving the transmitted frame relay network number, the DLCI number, and the process identifier information (receiving process information held the frame reception processing part 57) from the frame reception processing part 57.

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The traffic control part 56 starts by receiving a notification from the frame transmission processing part 55 or the frame reception processing part 57. The traffic control part 56 reads the restrictive class out from the restrictive class management table 50 (see FIG. 6). Successively, the traffic control part 56 operates the restrictive level based on the value stored in the restrictive threshold management table 51 (see FIG. 7). Then, the traffic control part 56 reads out the process task number from the task number storage table 54 by using the restrictive class and the restrictive level, and the traffic control part 56 performs the process task corresponding to the process task number.

The transmission data initializing part 58 starts every predetermined cycle and initializes contents in the transmission data cumulative table 52.

Next, an explanation will be given of processes by each frame relay switch 31a-31i with reference to flow charts shown in FIGs. 11-14. As a premise, when a frame is received by one of frame relay switches 31a-31i, the frame F is stored in the MM 34a through the LS 44, the LC 43a, the MP 42 and the CHC 35b.

As shown in FIG. 11, in the step S01, it is determined whether a frame is received or not. The step S01 is repeated until a frame F is received. That is, the step S01 is a state that a receipt of a frame F is waited, thereafter the process is advanced to the step

In the step S02, it is determined whether the frame F is received from one of the IWFs 21a-21c or not. This determination is performed by referring the circuit number (DLCI number) which receives the frame F in the step S01. When it is determined that the frame F is received from one of the IWFs 21a-21c, the process is advanced to the step S03. When it is not determined that the frame F is received from one of the IWFs 21a-21c, it is determined that the frame F is received from one of the terminals 22a-22h or another frame relay switch 31, thereafter the process is advanced to the step S04.

25 In the step S05, the frame transmission processing
part 55 starts.

In the step S06, the frame transmission processing

part 55 retrieves the transmitted frame relay network retrieval table 53 by using the DLCI number stored in the core header 27 of the frame F as a retrieval key and reads the transmitted frame relay network number.

5 In the step S07, the frame transmission processing part 55 informs the transmitted frame relay network number obtained in the step S06, the DLCI number, and the transmission process information which is the process identifier information the traffic control part
10 56. Then, the traffic control part 56 starts.

 In the step S08, the traffic control part 56 retrieves the restrictive class management table 50 (see FIG. 6) by using the transmitted frame relay network number received from the frame transmission processing
15 part 55 and the DLCI number as retrieval keys and reads out the restrictive class corresponding to the retrieval keys.

 In the step S09, the traffic control part 56 retrieves the restrictive threshold management table 51
20 (see FIG. 7) by using the transmitted frame relay network number received from the frame transmission processing part 55 as a retrieval key and operates the restrictive level by using each value stored correspondingly to the retrieval key. FIG. 12 is a flow
25 chart illustrating a traffic restrictive level operating subroutine performed in the step S09.

 In the step S101 in this subroutine, first, the

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traffic control part 56 retrieves the restrictive
threshold management table 51 by using the transmitted
frame relay network number received from the frame
transmission processing part 55 as a retrieval key and
5 reads out maxR, t1, n1, n2, n3 and n4 corresponding to
the retrieval key.

In the step S102, the traffic control part 56
retrieves the transmission data cumulative table 52 (see
FIG. 8) by using the transmitted frame relay network
10 number received from the frame transmission processing
part 55 as a retrieval key and reads out a cumulative
transmission data quantity (SD2) corresponding to the
retrieval key.

In the step S103, the traffic control part 56
15 calculates the transmission quantity of the frame F to
be transmitted to one of the IWFs 21a-21c by using the
following (expression 6);

$$\text{sd}(\text{bit}) = ([\text{transmission data} + 2 + 2 + 4] \div 48 + 1) \times 53 \times 8$$
$$\dots (\text{expression 6}).$$

20 In the (expression 6), the transmission data indicates
the number of octets of the core header 27 and the data
part 28 in the frame F to be transmitted to one of the
IWFs 21a-21c. The " $([\text{transmission data} + 2 + 2 + 4] \div 48 + 1)$ "
in the (expression 6) indicates the number of cells S
25 formed by disassembling the frame F. The " $\times 53$ " works out
the number of octets of all cells S (data quantity) when
a frame F is disassembled into plural cells S. The " $\times 8$ "

converts the number of octets to the number of bits.

In the step S104, the traffic control part 56 adds the SD2 obtained in the step S102 to the sd obtained in the step S103. The added value becomes transmission data
5 quantity (SD) in the channel (data link) connecting between the frame relay network and the IWF (SD2+sd=SD).

In the step S105, the traffic control part 56 determines whether the (SD2+sd) satisfies the condition shown in the following (expression 7) or not;

10 $SD2+sd \leq \max R \times t1 \times n1$... (expression 7).

When the condition of the (expression 7) is satisfied, the operation is advanced to the step S106, and when the condition of the (expression 7) is not satisfied, thereafter the process is advanced to the step S107.

15 In the step S106, the traffic control part 56 determines that the SD2+sd (SD) satisfies the condition of the (expression 1), namely, the restrict level is non-restriction, and the determined result is stored in the MM 34a. Thereafter, the process is advanced to the
20 step S114.

In the step S107, the traffic control part 56 determines whether the (SD2+sd) satisfies the condition shown in the following (expression 8) or not;

$SD2+sd \leq \max R \times t1 \times n2$... (expression 8).

25 When the condition of the (expression 8) is satisfied, the process is advanced to the step S108, and when the condition of the (expression 8) is not satisfied, the

operation is advanced to the step S109.

In the step S108, the traffic control part 56 determines that the (SD2+sd) satisfies the condition of the (expression 2), namely, the restrict level is the first restriction, and the determined result is stored in the MM 34a. Thereafter, the process is advanced to the step S114.

In the step S109, the traffic control part 56 determines whether the (SD2+sd) satisfies the condition shown in the following (expression 9) or not;

$$SD2+sd \leq \max R \times t1 \times n3 \quad \dots (\text{expression } 9).$$

When the condition of the (expression 9) is satisfied, the process is advanced to the step S110, and when the condition of the (expression 9) is not satisfied, the process is advanced to the step S111.

In the step S110, the traffic control part 56 determines that the (SD2+sd) satisfies the condition of the (expression 3), namely, the restrict level is the second restriction, and the determined result is stored in the MM 34a. Thereafter, the operation is advanced to the step S114.

In the step S111, the traffic control part 56 determines whether the (SD2+sd) satisfies the condition shown in the following (expression 10) or not;

$$SD2+sd \leq \max R \times t1 \times n4 \quad \dots (\text{expression } 10).$$

When the condition of the (expression 10) is satisfied, the process is advanced to the step S112, and when the

condition of the (expression 10) is not satisfied, the process is advanced to the step S113.

In the step S112, the traffic control part 56 determines that the (SD2+sd) satisfies the condition of the (expression 4), namely, the restrict level is the third restriction, and the determined result is stored in the MM 34a. Thereafter, the process is advanced to the step S114.

In the step S113, the traffic control part 56 stores the fourth restriction as a restrict level in the MM 34a. Thereafter, the process is advanced to the step S114.

In the step S114, the traffic control part 56 retrieves the transmission data cumulative table 52 (see FIG. 8) by using the transmitted frame relay network number as a retrieval key, and over writes the (SD+sd) as a new transmission data quantity (SD2) stored correspondingly to the retrieval key. At the same time, the traffic control part 56 over writes the restrictive level memorized in one of the steps S106, S108, S110, S112 and S113 as a new restrictive level to be stored. Thereafter, the process in the step S114 is finished, the process returns to the main routine in FIG. 11. In the main routine to which the process is returned, the step S10 is performed.

In the step S10, the traffic control part 56 retrieves the task number storage table 54 (see FIG. 10)

by using the process identifier information
(transmission process information) received from the
frame transmission processing part 55, the restrictive
class obtained in the step S08 and the restrictive level
5 obtained in the step S09 as retrieval keys, and reads a
process task number (one of process tasks (1)-(4))
corresponding to the retrieval keys.

In the step S11, the traffic control part 56 starts
(performs) the process task corresponding to the process
10 task number read in the step 10. FIG. 13 is a flow chart
showing a process task starting subroutine performed in
the step 11. In the step S202 in this subroutine, the
traffic control part 56 determines whether the process
task number calculated in the step S09 is "(1)" or not.
15 When it is determined that the process task number is
"(1)", the process is advanced to the step S202. When it
is not determined that the process task number is "(1)",
the process is advanced to the step S203.

In the step S202, the traffic control part 56
20 performs the process task (1). That is, the traffic
control part 56 informs the frame transmission
processing part 55 that the frame F to be transmitted to
one of the IWFs 21a-21c is unnecessary to be discarded.
When the performance of the process task (1) is
25 finished, the process returns to the step S12.

In the step S203, the traffic control part 56
determines whether the process task number calculated in

the step S09 is "(2)" or not. When it is determined that the process task number is "(2)", the process is advanced to the step S204. When it is not determined that the process task number is "(2)", the process is
5 advanced to the step S206.

In the step S204, the traffic control part 56 performs the process task (2). That is, "1" is set in the FECN of the core header 27 in the frame F to be transmitted to one of the IWFs 21a-21c. At the same
10 time, the traffic control part 56 informs the frame transmission processing part 55 that the frame F to be transmitted to one of the IWFs 21a-21c is unnecessary to be discarded. When the performance of the process task (2) is finished, the process returns to the step S12.
15 This process task (2) is performed, whereby a transmitted terminal (an user of a transmitted terminal) recognizes that a congestion occurs in the frame relay network FR1-FR3, and a congestion avoiding procedure (congestion control) is performed.

20 In the step S206, the traffic control part 56 determines whether the process task number calculated in the step S09 is "(2)" or not. When it is determined that the process task number is "(3)", the process is advanced to the step S207. When it is not determined
25 that the process task number is "(3)", the process is advanced to the step S211.

In the steps S207-S210, the traffic control part 56

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performs the process task (3).

That is, in the step S207, the traffic control part 56 determines whether "0" is set in the DE of the core header 27 in the frame F or not. When "0" is set in the DE, the process is advanced to the step S208. When "0" is not set in the DE (namely, DE=1), the process is advanced to the step S210.

In the step S208, the traffic control part 56 sets "1" in the FECN of the core header 27 in the frame F to be transmitted to one of the IWFs 21a-21c. With this arrangement, the transmitted terminal of the frame F performs a congestion avoiding procedure (congestion control), and the transmission of the frame F by the transmitted terminal is controlled.

15 In the step S209, the traffic control part 56
informs the frame transmission processing part 55 that
the frame F to be transmitted to one of the IWFs 21a-21c
is unnecessary to be discarded. When the step 209 is
finished, the process returns to the main routine shown
20 in FIG. 11.

In the step S210, the traffic control part 56 informs the frame transmission processing part 55 that the frame F to be transmitted to one of the IWFs 21a-21c is discarded. When the step 210 is finished, the process returns to the main routine shown in FIG. 11.

In the step S211, the traffic control part 56 determines whether the process task number calculated in

the step S09 is "(4)" or not. When it is determined that the process task number is "(4)", the process is advanced to the step S212. When it not is determined that the process task number is "(4)", the process
5 returns to the main routine shown in FIG. 11.

In the step S212, the traffic control part 56 performs the process task (4). That is, similarly to the process in the step S210, the traffic control part 56 informs the frame transmission processing part 55 that
10 the frame F to be transmitted to one of the IWFs 21a-21c is discarded. Then, the performance of the process task (4) is finished, the process returns to the main routine shown in FIG. 11. In the main routine which the process is returned, the step S12 is performed.

15 In the step S12, the frame transmission processing part 55 determines whether the notification received from the traffic control part 56 indicates that the frame F is necessary to be discarded or not. When it is determined that the notification indicates that the
20 frame F is necessary to be discarded, the process is advanced to the step S13. When it is determined that the notification does not indicate that the frame F is necessary to be discarded (indicates that the frame F is unnecessary to be discarded), the process is advanced to
25 the step S14.

In the step S13, the frame transmission processing part 55 discards the frame F to be transmitted to one of

the IWFs 21a-21c. With this arrangement, the number of cells transmitted from the IWFs 21a-21c to the ATM network 20 is decreased, and it is prevented that the number of cells exceeds the PCR. When the step S13 is finished, the process returns to the step S01 and accepts the next frame F.

In the step S14, an usual process is performed. That is, the frame F is transmitted through a suitable data link (one of the DLCIa-DLCIh) based on the DLCI number stored in the core header 27 of the frame F. Then, the process returns to the step S01 and accepts the next frame F.

On the contrary, when the process is advanced to the step S03, the frame receiving process is performed. FIG. 14 is a flow chart showing a frame receiving process subroutine performed in the step S03. In the step S301 in this subroutine, first, the frame reception processing part 57 starts.

In the step S302, the frame reception processing part 57 retrieves the transmitted frame relay network number retrieval table 53 (see FIG. 9) by using the DLCI number stored in the core header 27 of the frame F as a retrieval key, and reads the transmitted frame relay network number corresponding to the retrieval key.

In the step S303, the frame reception processing part 57 informs the traffic control part 56 of the transmitted frame relay network number obtained in the

step S302, the DLCI number and the process identifier information (reception process information) held therein so as to start the traffic control part 56.

In the step S304, the traffic control part 56
5 retrieves the restrictive class management table 50 (see FIG. 6) by using the transmitted frame relay network number and the DLCI number received from the frame reception processing part 57 as retrieval keys, and
reads out a restrictive class corresponding to the
10 retrieval keys.

In the step S305, the traffic control part 56
retrieves the transmission data cumulative table 52 (see FIG. 8) by using the transmitted frame relay network number received from the frame reception processing part
15 57 as a retrieval key, and reads out a traffic restrictive level.

In the step S306, the traffic control part 56
retrieves the task number storage table 54 (see FIG. 10) by using the process identifier of the reception process
20 received from the frame reception processing part 57, the restrictive class obtained in the step S304 and the restrictive level obtained in the step S305 as retrieval keys, and reads out the process task number (one of the process tasks (1), (5)) corresponding to the retrieval
25 keys.

In the step S307, the traffic control part 56 determines whether the process task number read in the

step S306 is "(1)" or not. When it is determined that the process task number is "(1)", the process is advanced to the step S308. When it is not determined that the process task number is "(1)", the process is
5 advanced to the step S309.

In the step S308, the traffic control part 56 performs the process task (1). That is, the traffic control part 56 informs the frame reception processing part 57 that the frame F received in the frame relay
10 switch is unnecessary to be discarded. Then, the step S308 is finished, the process returns to the main routine shown in FIG. 11 and the usual process is performed in the step S14.

In the step S309, the traffic control part 56
15 determines whether the process task number read in the step S306 is "(5)" or not. When it is determined that the process task number is "(5)", the process is advanced to the step S310. When it is not determined that the process task number is "(5)", the process
20 returns to the step S309 and the usual process is performed in the step S14.

In the steps S310, S311, the process task (5) is performed. That is, in the step S310, the traffic control part 56 sets "1" in the BECN of the core header
25 27 in the frame F received by the frame relay switch 31. With this arrangement, the transmitted terminal which receives the frame F recognizes that a congestion occurs

Thus, the transmission of the frame F from the transmitted terminal is controlled.

5 In the step S311, the traffic control part 56
informs the frame reception processing part 57 that the
frame F received in the frame relay switch 31 is
unnecessary to be discarded. Then, the step S311 is
finished, the process returns to the main routine shown
10 in FIG. 11 and the usual process is performed in the
step S14. Incidentally, since the traffic control part
56 informs the frame reception processing part 57 only
that the frame F is unnecessary to be discarded, the
frame is not discarded by the frame reception processing
15 part 57.

Now, the transmission data cumulative value (SD2) set in the transmission data cumulative table 52 and the restrictive level are initialized by the transmission data initializing part 58 every predetermined period. That is, a transmitted frame relay network number is inputted into the transmission data initializing part 58 every predetermined period, whereby the transmission data initializing part 58 starts. The transmission data initializing part 58 retrieves the transmission data cumulative table 52 by using the transmitted frame relay network number inputted thereto as a retrieval key, and then makes the transmission data quantity value (SD2)

zero-clear and the restrictive level to be non-restriction. Additionally, the period which the same transmitted frame relay network number is inputted is set so as to be the same time as the measuring time (t1) set correspondingly to that transmitted frame relay network number in the restrictive threshold management table 51. Thus, the stored content in the transmission data cumulative table 52 is initialized every transmitted frame relay network number, namely, whenever the t1 corresponding to that network number passes.

Next, an explanation will be given of an operational sample in this network system with reference to FIG. 15. FIG. 15 is a sequence diagram illustrating an operational sample in a case that a frame F is transmitted and received between the terminal 22a and the terminal 22e.

Referring to FIG. 15, first, in each frame relay switch 31a, 31b, 31g in the frame relay network FR1, it is assumed that the transmission data initializing part 58 initializes the content in the transmission data cumulative table 52, which the content is stored correspondingly to the network number of the frame relay network FR2.

Then, it is assumed that after transmitting and receiving the frame F between the terminal 22a and the terminal 22e, a frame F₁ which is transmitted from the terminal 22a to the terminal 22e to be a transmitted

terminal is transmitted to the frame relay network FR1
(frame relay switch 31a).

The frame F_1 , as shown in FIG.2, is transmitted to
the frame relay switch 31a through the DLC1a. At that
5 time, "0" to be an initialized value is set in the FECN
of the core header 27 in the frame F_1 .

In the frame relay switch 31a, when the frame F_1 is
received, the usual process is performed in the step S14
(see FIG. 11), and then the frame F_1 is transmitted to
10 the frame relay switch 31g through the DLC1a based on
the DLCI number stored in the core header 27 thereof.

In the frame relay switch 31g, it is determined
that the frame F_1 should be transmitted to the IWF 21a
in the step S04. Then, the restrictive class is read in
15 the step S08, and the restrictive level is calculated in
the step S09 (see FIG. 11). At that time, for example,
when the first restriction is memorized as the
restrictive level (step S108: see FIG. 12), the process
task (2) is performed so as to set "1" in the FECN of
20 the core header 27 in the frame F_1 (step S204: see FIG.
13). Then, the usual process is performed in the step
S14, whereby the frame F_1 is transmitted to the IWF 21a
through the DLC1a.

In the IWF 21a, the frame F_1 is disassembled into
25 plural cells S_1 , and each cell S_1 is transmitted to the
ATM network 20 via the VCCx₁.

In the ATM network 20, a transmitted destination of

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each cell S_1 is determined based on the VCI and the VPI (see FIG. 3) stored in the cell header 70 thereof, and then each cell S_1 is transmitted to the IWF 21b via the VCCy.

5 In the IWF 21b, the plural cells S₁ respectively
received from the ATM network 20 are assembled into one
frame F₁. Then, the assembled frame F₁ is transmitted to
the frame relay network FR2 (frame relay switch 31h)
through the DLCIe based on the DLCI number stored in the
10 core header 27 thereof.

In the frame relay switch 31h, it is determined that the frame F_1 is received from the IWF 21b in the step S02, and then the frame reception process is performed in the step S03. Incidentally, at that time, it is assumed that the non-restriction is memorized as the restrictive level in the step S305 (see FIG. 14) and the process task (1) is performed. With this arrangement, no traffic restriction is performed, and the usual process is performed in the step S14, whereby the frame F_1 is transmitted to the frame relay switch 31c.

In the frame relay switch 31c, the usual process is performed in the step S14 after the steps S01-S04, and the frame F₁ is transmitted to the terminal 22e through the DLCIe based on the DLCI number stored in the core header 27 thereof.

When the terminal 22e receives the frame F_1 , the

terminal 22e recognizes that a congestion occurs in the frame relay network FR1 or FR2 based on that "1" is set in the FECN of the frame F_1 thereof, and then performs the congestion avoiding procedure (congestion control) so as to control the transmission of the frame F. With this arrangement, the number of frames F transmitted from the frame relay network FR2 to the IWF 21b decreases. The number of cells S transmitted from the IWF 21b to the ATM network 20 also decreases as the number of frames F decreases. Thus, it is prevented that the number of cells S in the VCCy exceeds the PCR.

Thereafter, the terminal 22e generates a response frame f_1 to the frame F_1 , and then transmits the response frame f_1 to the frame relay network FR2 (frame relay switch 31c) in regarding the terminal 22a as a transmitted destination.

In the frame relay switch 31c, when the response frame f_1 is received, the usual process is performed in the step S14 (see FIG. 11). With this arrangement, the response frame f_1 is transmitted to the frame relay switch 31h based on the DLCI number stored in the core header 27 thereof.

In the frame relay switch 31h, when the response frame f_1 is received and is determined to be transmitted to the IWF 21b, the traffic restrictive level is calculated in the step S09. Incidentally, it is assumed that the non-restriction is memorized in the step S106

(see FIG. 12) and the process task (1) is performed in the step S202 (see FIG. 13). Then, the usual process is performed in the step S14, and the response frame f_1 is transmitted to the IWF 21b through the DLCIe.

5 In the IWF 21b, the response frame f_1 is disassembled into plural cells s_1 , and then the plural cells s_1 are transmitted to the ATM network 20 through the VCCy.

10 In the ATM network 20, each cell s_1 is transmitted to the IWF 21a through the VCCx₁ based on the VPI and the VCI stored in the cell header 70.

15 In the IWF 21a, plural cells s_1 are assembled to one response frame f_1 . Then, the response frame f_1 is transmitted to the frame relay network FR1 (frame relay switch 31g) through the DLCIa based on the DLCI number stored in the core header 27 thereof.

20 In the frame relay switch 31g, when it is determined that the response frame f_1 is received from the IWF 21a, the frame reception process is performed in the step S03. That is, as shown in FIG. 14, the first restriction is memorized as the restrictive level in the step S305, and "1" is set in the BECN of the core header 27 in the step S310. Then, the usual process is performed in the step S14, the response frame f_1 is transmitted to the frame relay switch 31a.

25

 In the frame relay switch 31a, the usual process is performed in the step S14, and the response frame f_1 is

transmitted to the terminal 22a.

In the terminal 22a, it is recognized that a congestion occurs in the frame relay network FR1 or FR2 based on that "1" is set in the BECN of the frame F_1 thereof, and then performs the congestion avoiding procedure (congestion control) so as to control the transmission of the frame F. With this arrangement, the transmission of frames F transmitted from the terminal 22a to the terminal 22e as a transmitted terminal is controlled. Thus, the number of cells S transmitted from the IWF 21a through the $VCCx_1$ decreases, and then it is prevented that the number of cells S exceeds the PCR.

Thereafter, when the measuring time t_1 (stored in the restrictive threshold management table 51 correspondingly to the network number of the frame relay network FR2) passes, the network number of the frame relay network FR2 (transmitted frame relay network number) is inputted into the transmission data initializing part 58 (see FIG. 5). With this arrangement, the transmission data initializing part 58 starts, whereby the value SD2 which is stored in the transmission data cumulative table 52 (see FIG. 8) correspondingly to the network number of the frame relay network FR2 is made zero-clear and the non-restriction is set as the traffic restrictive level. The initialization is performed like this.

Thereafter, it is assumed that after receiving and

transmitting a frame F not shown between the terminal 22a and the terminal 22e, the terminal 22a transmits a frame F_2 which regards the terminal 22e as a transmitted terminal to the frame relay network FR1.

5 The frame F_2 is received by the frame relay switch 31g through the frame relay switch 31a in the frame relay network FR1. Then, the traffic restrictive level is calculated in the step S09 as above mentioned. Here, the process is advanced to the step S113 and the fourth
10 restriction is memorized as the restrictive level. When a discard is notified in the step S212, the frame F_2 is discarded in the step S13.

When the measuring time t_1 passes again, the transmission data initializing part 58 starts. The
15 transmission data initializing part 58 initializes the value SD2 and the traffic restrictive level stored in the transmission data cumulative table 52 correspondingly to the network number of the frame relay network FR2. With this arrangement, the traffic
20 restriction corresponding to the DLC1a becomes the non-restriction from the fourth restriction.

According to this embodiment, when a frame F is transmitted from one of the frame relay networks FR1-FR3 to one of the IWFs 21a-21c, or when a frame F (response
25 frame) is received from one of the IWFs 21a-21c to one of the frame relay networks FR1-FR3, a traffic restrictive class is detected and a traffic restrictive

level corresponding to the transmission data quantity
(SD) is calculated, and then a process task
corresponding to the restrictive class and the
restrictive level is performed. The process task is
5 performed, whereby a congestion avoiding procedure
(congestion control) for the frame relay network FR1-FR3
is performed in a transmitting terminal and a
transmitted terminal of the frame F. Moreover, according
to the restrictive level, a frame F is discarded in one
10 of the frame relay networks FR1-FR3. Thus, there is no
case that the number of cells S transmitted to the ATM
network 20 exceeds a determined PCR.

Thus, it can be prevented that a cell S (frame F)
is discarded in the ATM network 20. According to this,
15 it is possible to avoid a congestion caused by that the
number of cells S exceeds the PCR in the frame relay
network FR1-FR3. Further, since the re-transmission of
the frame in the terminal 22a-22h can be reduced, it is
possible to lighten the process load in the frame relay
20 network FR1-FR3 and it is possible to avoid a response
deterioration of the communication from a terminal to a
terminal (end to end).

Additionally, a restrictive class can be set in
accordance with the importance of the DLCIa-DLCIh, and a
25 traffic restrictive process can be performed in
accordance with each restrictive class, therefore, it is
possible to discriminate each DLCI and to perform a

traffic process more suitably.

In this embodiment, as shown in FIG. 2, data links (DLCI) between frame relay networks and IWFs and a VCC between the IWF and the ATM network are set in the ratio of N:1, however, a data link and a VCC may be set in the ratio of 1:1.

Each frame relay switch 31a-31i in this embodiment, when "1" is set in the BECN of the frame by performing a process task, may generate a CLLM (Consolidated Link Layer Management) message for notifying a congestion occurrence to a transmitting terminal of the frame and may transmit it to the transmitting terminal, and each frame relay switch may transmit a CLLM message to a transmitting terminal instead of setting "1" in the BECN.

In this embodiment, a restrictive class and a restrictive level are detected every transmitted frame relay network and a process task (1)-(5) is performed, however, a restrictive class and a restrictive level may be obtained every transmitting frame relay network and a process task corresponding to those may be performed. That is, one of the terminals 22e-22h in FIG. 1 may be directly connected to the IWFs 21b, 21c not through the frame relay networks FR2, FR3.

Moreover, the frame relay networks FR1-FR3 are respectively provided with the plural frame relay switches 31a-31i, however, the frame relay networks FR1-

FR3 may be provided with one frame relay switch, namely, it is not necessary to care the number of frame relay switches in a frame relay network.

Further, it is possible to vary the measuring time
5 t1. For example, the above-mentioned traffic process may be performed at a real time.

According to a traffic control method, a network system and a frame relay switch of the present invention, it can be prevented that the number of cells
10 transmitted to an ATM network exceeds a maximum transmission rate. Thus, it can be prevented that cells are discarded caused by that the number of cells exceeds the maximum transmission rate and a congestion occurs in frame relay networks.

15 This invention being thus described, it will be obvious that same may be varied in various ways. Such variations are not to be regarded as departure from the spirit and scope of the invention, and all such modifications would be obvious for one skilled in the
20 art intended to be included within the scope of the following claims.

What is claimed is:

1. A traffic control method in a network system comprising an ATM (Asynchronous Transfer Mode) network, plural frame relay networks respectively connected to the ATM network through channels and plural terminals respectively connected to the plural frame relay networks through channels, said traffic control method comprising:
- 5
- a step of measuring a data quantity transmitted through each channel;
- 10
- a step of operating a traffic restrictive level corresponding to the data quantity which is measured; and
- a step of performing a traffic restrictive process corresponding to the traffic restrictive level which is operated.
- 15
- 20
2. A traffic control method according to the claim 1, wherein the data quantity is measured as to data transmitted from each of the plural frame relay networks to the ATM network through the each channel.
3. A traffic control method according to the claim 1, further comprising:
- a step of detecting a traffic restrictive class set for the each channel; and

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a step of performing the traffic restrictive process corresponding to the traffic restrictive class which is detected.

4. A traffic control method according the claim 1,
5 wherein said traffic restrictive process comprises a process for writing information indicating that a congestion occurs to data transmitted through the each channel.

5. A traffic control method according the claim 1,
10 wherein said traffic restrictive process comprises a process for discarding data transmitted through the each channel.

6. A traffic control method according the claim 1,
wherein said traffic restrictive process comprises a
15 process for transmitting a message indicating that a congestion occurs to a transmitting terminal of data transmitted through the each channel.

7. A traffic control method according the claim 1,
wherein said traffic restrictive process is performed
20 based on a maximum transmission rate set for the each channel.

8. A traffic control method according to the claim

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1, wherein at least one of the plural terminals is connected to the ATM network through no frame relay network.

9. A network system comprising:

5 an ATM (Asynchronous Transfer Mode) network;
plural frame relay networks respectively connected to the ATM network through channels;

plural terminals respectively connected to the plural frame relay networks through channels;

10 data quantity measurement means for measuring a data quantity transmitted through each channel;

restrictive level operation means for operating a traffic restrictive level corresponding to the data quantity measured by said data quantity measurement
15 means; and

traffic control means for performing a traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation means.

20 10. A network system comprising:

an ATM (Asynchronous Transfer Mode) network;
plural frame relay networks respectively connected to the ATM network through channels;

plural terminals respectively connected to the
25 plural frame relay networks through channels;

data quantity measurement means for measuring a data quantity transmitted through each channel;

restrictive level operation means for operating a traffic restrictive level corresponding to the data
5 quantity measured by said data quantity measurement means;

restrictive process storage means for storing a traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level
10 operation means; and

traffic control means for reading the traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation means from said restrictive process storage
15 means and for performing the traffic restrictive process read from said restrictive process storage means.

11. A network system according to the one of the claims 9 and 10, wherein at least one of the plural terminals is connected to the ATM network through no
20 frame relay network.

12. A frame relay switch in plural frame relay networks in a network system comprising an ATM (Asynchronous Transfer Mode) network, said plural frame relay networks respectively connected to the ATM network
25 through channels and provided with plural frame relay

switch, and plural terminals respectively connected to the plural frame relay networks through channels, said frame relay switch comprising:.

data quantity measurement means for measuring a
5 data quantity transmitted through each channel;

restrictive level operation means for operating a traffic restrictive level corresponding to the data quantity measured by said data quantity measurement means;

10 restrictive process storage means for storing a traffic restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation means; and

traffic control means for reading the traffic
15 restrictive process corresponding to the traffic restrictive level operated by said restrictive level operation means and performing the traffic restrictive process read from said restrictive process storage means.

20 13. A frame relay switch according to the claim 12, wherein said data quantity measurement means measures the data quantity transmitted from each of the plural frame relay networks to the ATM network.

14. A frame relay switch according to one of the
25 claims 12 and 13, further comprising:

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restrictive class storage means for storing a traffic restrictive class set for each channel transmitting data from the plural frame relay network to the ATM network,

5 wherein said traffic control means read the traffic restrictive class from said restrictive class storage means, detect the traffic restrictive process stored correspondingly to the traffic restrictive class read from said restrictive process storage means and the
10 traffic restrictive level operated by said restrictive level operation means, and performs the traffic restrictive process which is detected.

15 15. A frame relay switch according to the claim 12, wherein said traffic restrictive process comprises a process for writing information indicating that a congestion occurs into data transmitted through the each channel.

20 16. A frame relay switch according to the claim 12, wherein said traffic restrictive process comprises a process for discarding data transmitted through the each channel.

17. A frame relay switch according to the claim 12, wherein said traffic restrictive process comprises a process for transmitting information indicating that a

congestion occurs to a transmitting terminal of data
transmitted through the each channel.

18. A frame relay switch according to the claim 12,
wherein said traffic restrictive process is based on a
5 maximum transmission rate set for the each channel.

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ABSTRACT OF THE DISCLOSURE

5 A traffic control method can prevent that the
number of cells transmitted to an ATM network exceeds a
maximum transmission rate. When a frame F is transmitted
from a frame relay network FR1 to an IWF, a traffic
control part included in the frame relay network FR1
measures the transmission data quantity for a measuring
time in a DLCI connecting the frame relay network FR1
and the IWF. Successively, the traffic control part
10 detects a traffic restrictive level corresponding to the
measured transmission data quantity. Then, the traffic
restrictive process corresponding to the restrictive
level is performed, and the frame transmission is
controlled by the transmitted terminal of the frame F.
15 Thus, it is prevented that the number of cells
transmitted to the ATM network exceeds a determined
maximum transmission rate.

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FIG. 2

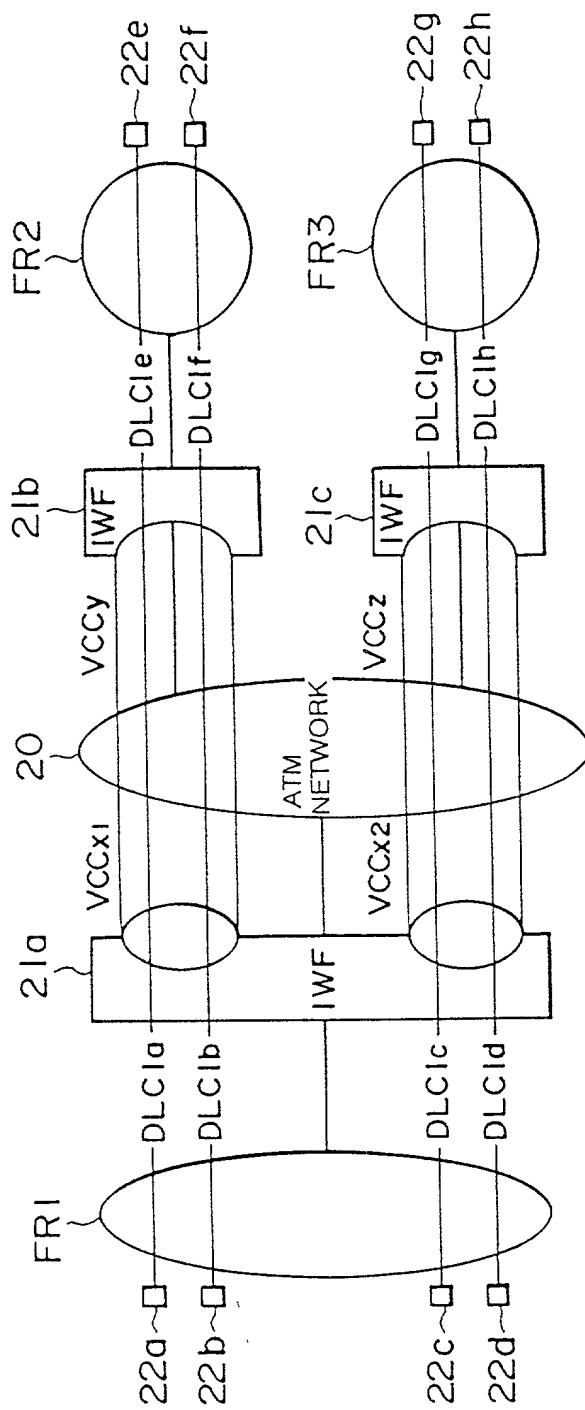


FIG. 3(a)

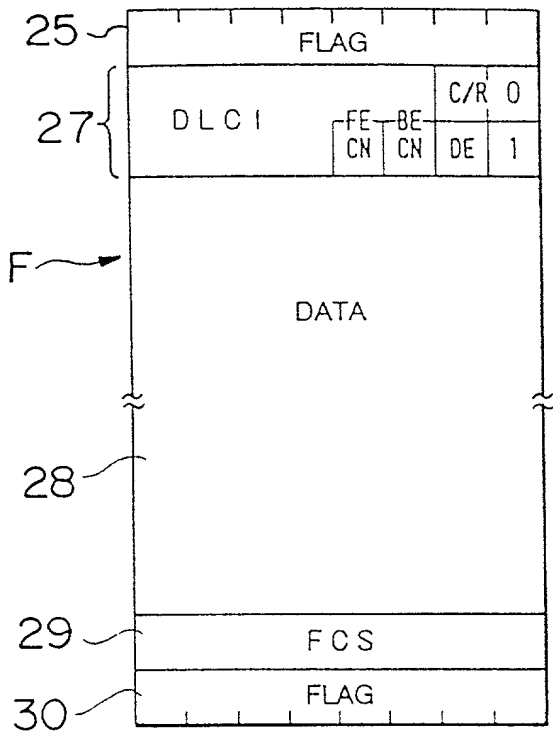
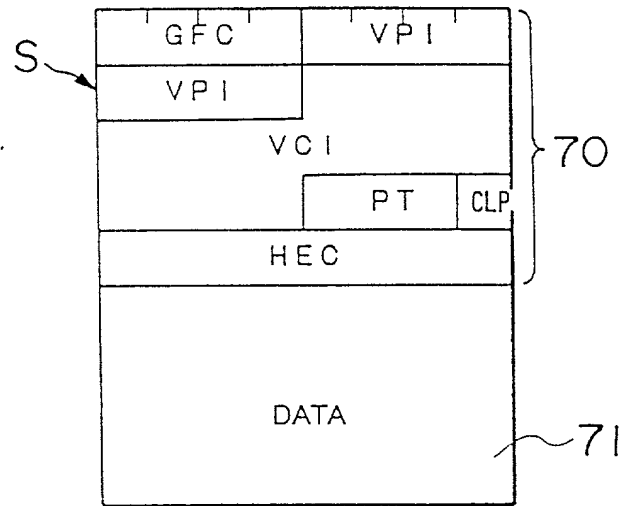


FIG. 3(b)



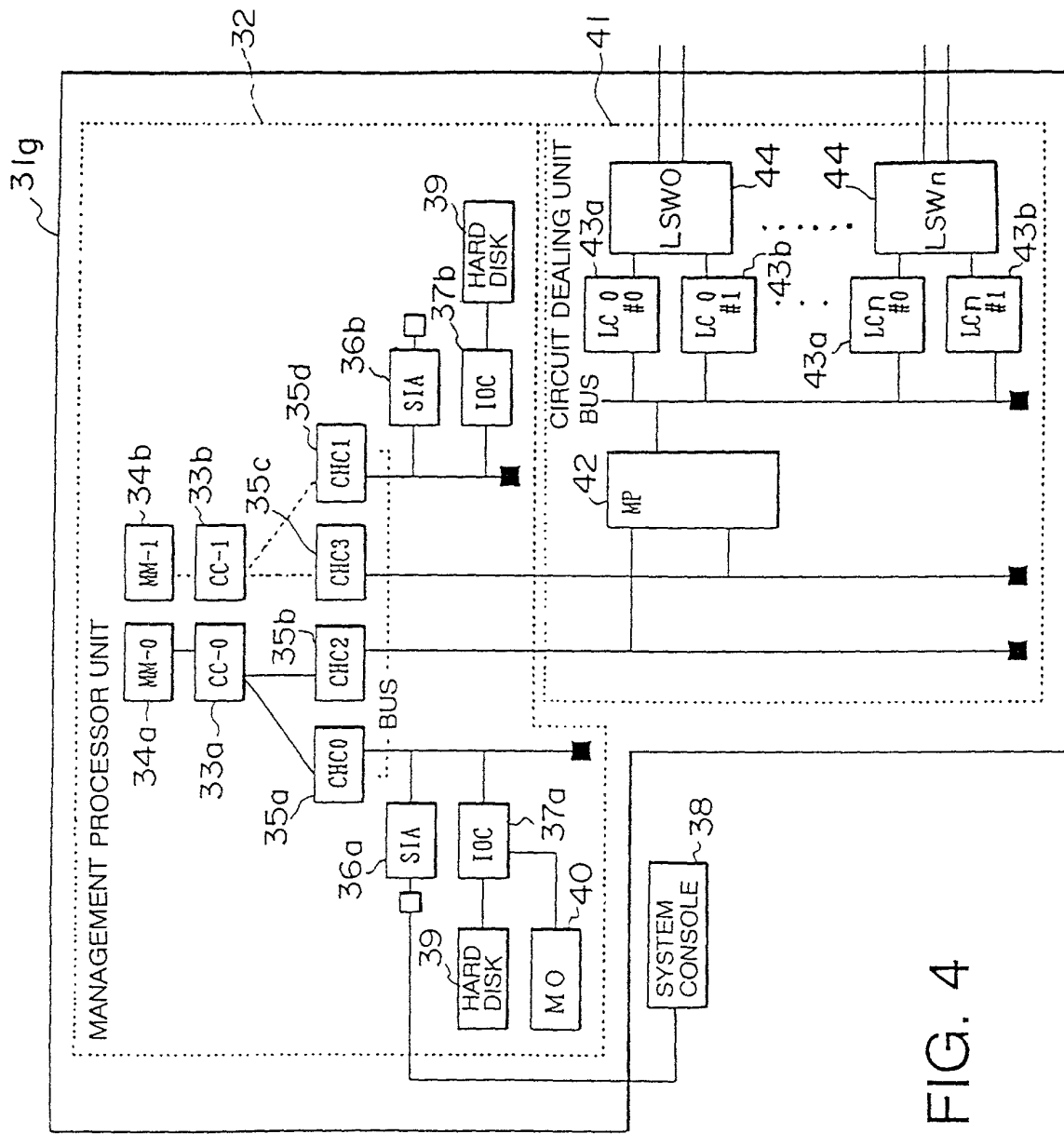


FIG. 4

FIG. 5

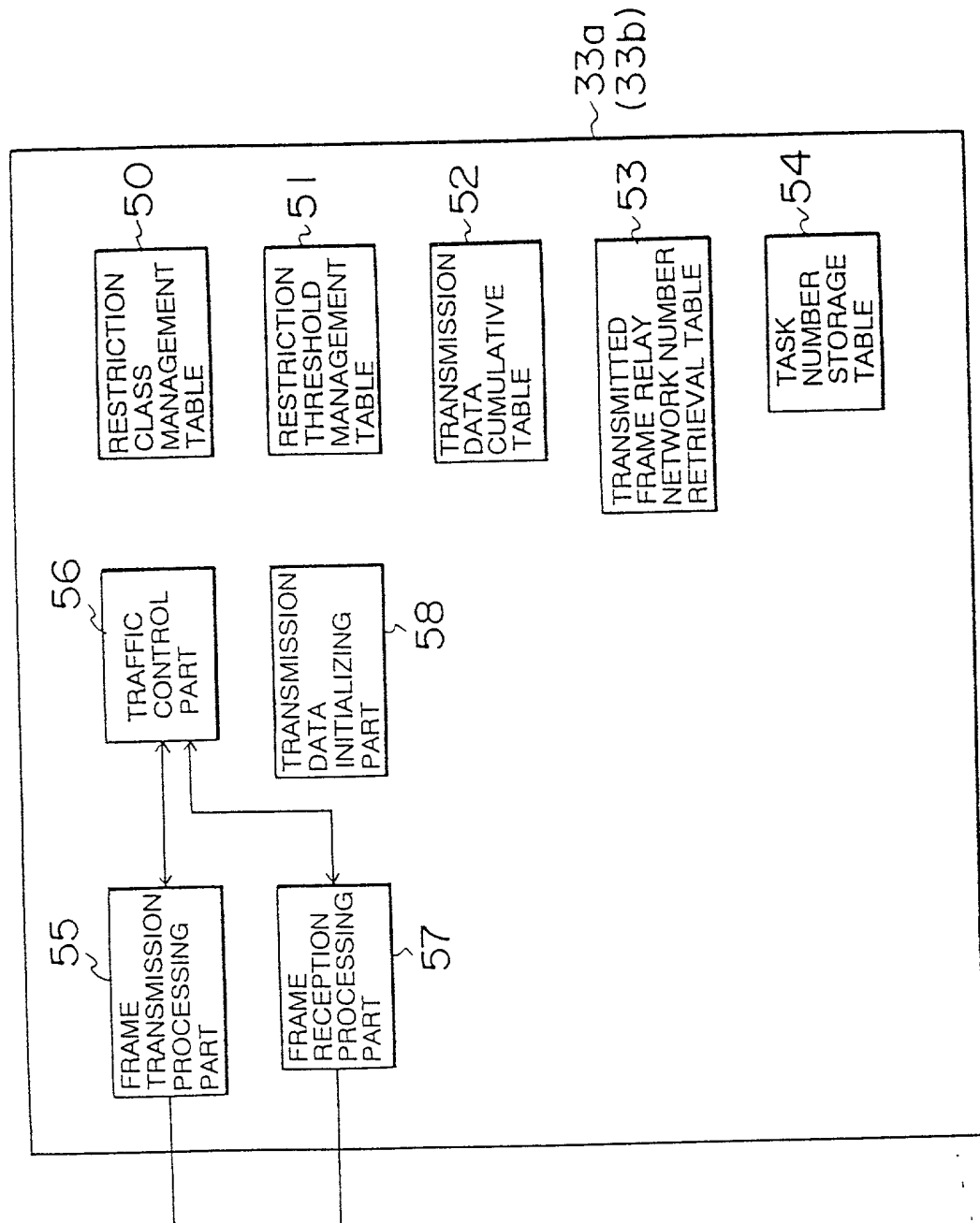


FIG. 10

GENERAL CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	54
	PROCESS TASK 2 (FIRST RESTRICTION)		
	PROCESS TASK 3 (SECOND RESTRICTION)		
	PROCESS TASK 3 (THIRD RESTRICTION)		
	PROCESS TASK 4 (FOURTH RESTRICTION)		
IMPORTANT CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	
	PROCESS TASK 1 (FIRST RESTRICTION)		
	PROCESS TASK 2 (SECOND RESTRICTION)		
	PROCESS TASK 3 (THIRD RESTRICTION)		
	PROCESS TASK 4 (FOURTH RESTRICTION)		
MOST IMPORTANT CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	
	PROCESS TASK 1 (FIRST RESTRICTION)		
	PROCESS TASK 1 (SECOND RESTRICTION)		54a
	PROCESS TASK 1 (THIRD RESTRICTION)		59
	PROCESS TASK 4 (FOURTH RESTRICTION)		
GENERAL CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	
	PROCESS TASK 5 (FIRST RESTRICTION)		
	PROCESS TASK 5 (SECOND RESTRICTION)		54b
	PROCESS TASK 5 (THIRD RESTRICTION)		59
	PROCESS TASK 5 (FOURTH RESTRICTION)		
IMPORTANT CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	
	PROCESS TASK 1 (FIRST RESTRICTION)		
	PROCESS TASK 5 (SECOND RESTRICTION)		
	PROCESS TASK 5 (THIRD RESTRICTION)		
	PROCESS TASK 5 (FOURTH RESTRICTION)		
MOST IMPORTANT CLASS	PROCESS TASK 1 (NON-RESTRICTION)	59	
	PROCESS TASK 1 (FIRST RESTRICTION)		
	PROCESS TASK 1 (SECOND RESTRICTION)		
	PROCESS TASK 1 (THIRD RESTRICTION)		
	PROCESS TASK 5 (FOURTH RESTRICTION)		

FIG. 12

FIG. 13

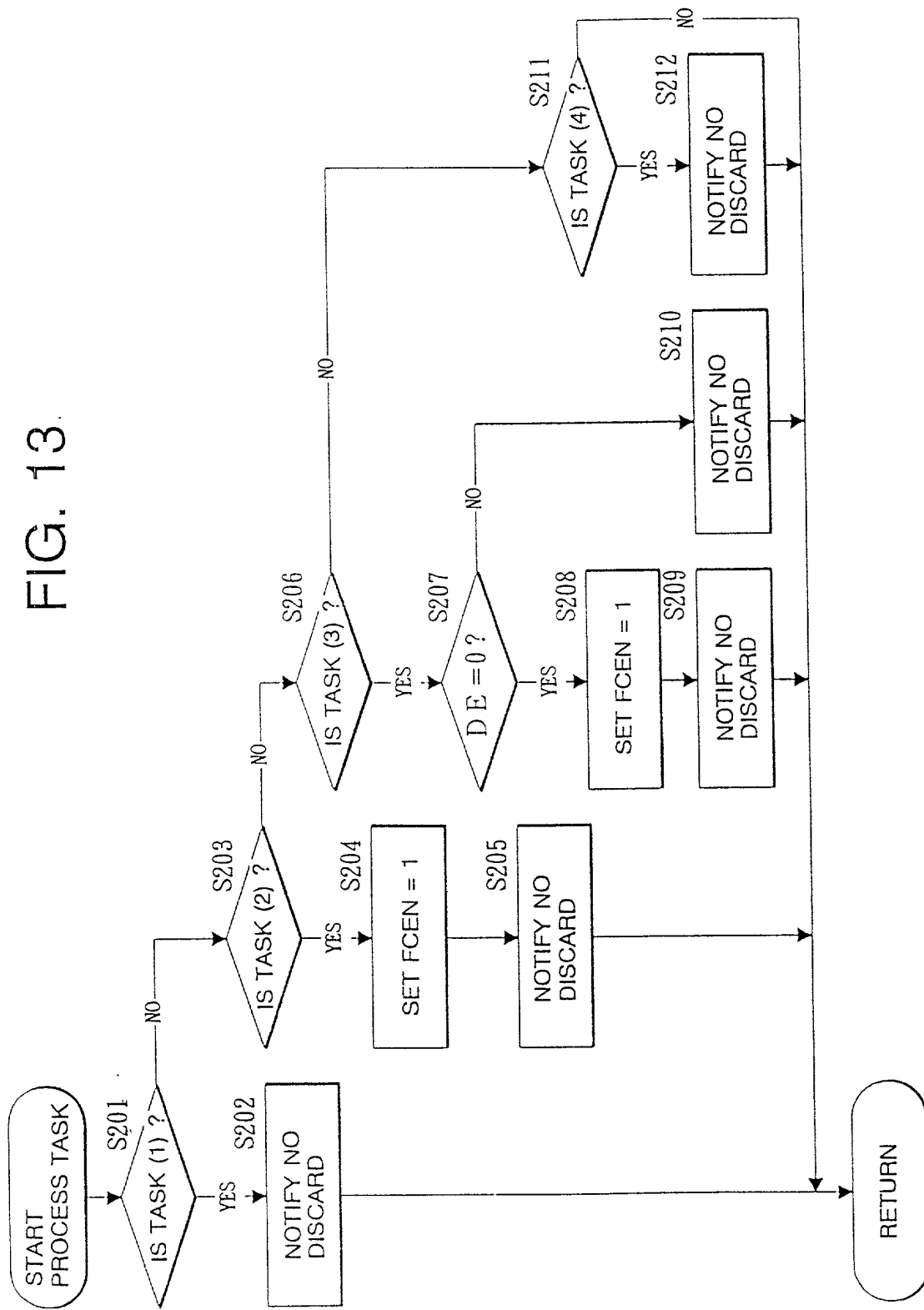


FIG. 15

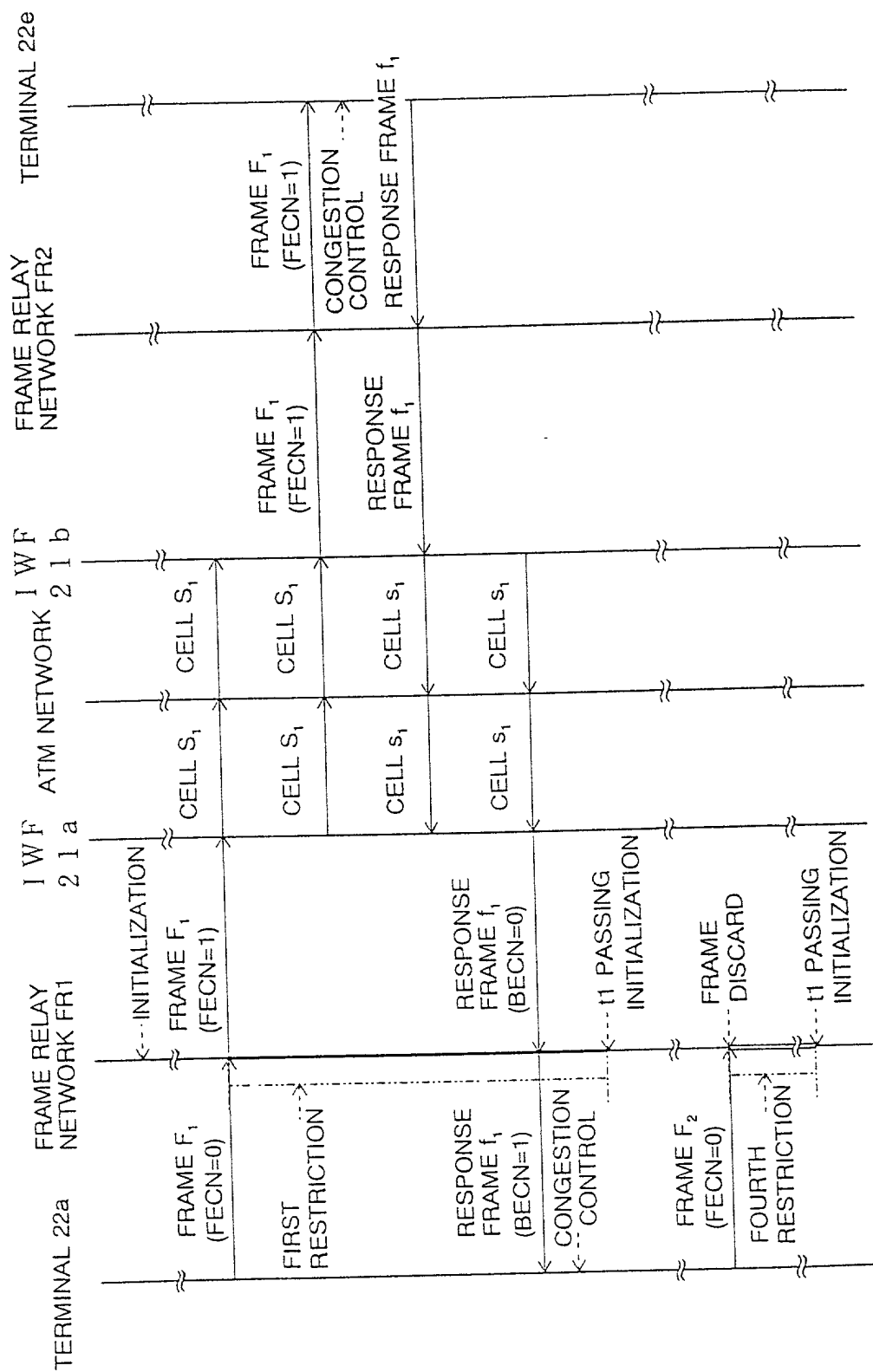


FIG. 16

PRIOR ART

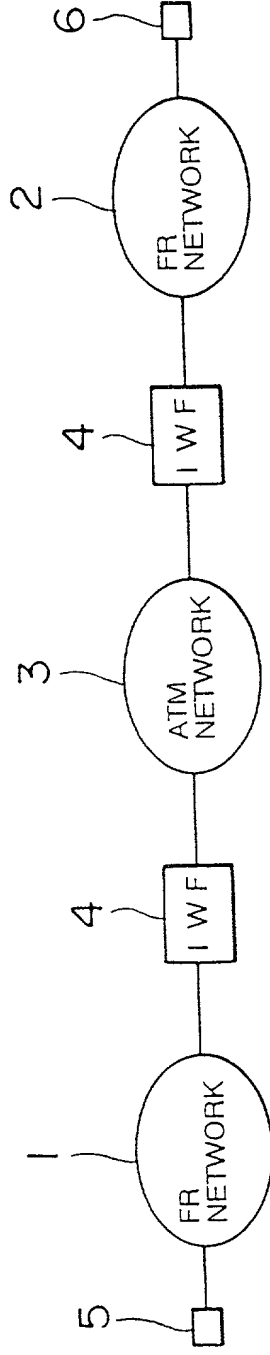


FIG. 17

RESTRICTIVE LEVEL		TRAFFIC RESTRICTIVE CLASS		GENERAL CLASS		IMPORTANT CLASS		MOST IMPORTANT CLASS	
NON-RESTRICTION			$SD \leq \max RX \text{ t l X n l}$	NO RESTRICTION		NO RESTRICTION		NO RESTRICTION	
				TRANSMITTED FRAME : FECN=1 RECEIVED FRAME : BECN=1					
FIRST RESTRICTION			$\max RX \text{ t l X n l} < SD \leq \max RX \text{ t l X n 2}$	TRANSMITTED FRAME DE=0:FECN=1 RECEIVED FRAME : BECN=1		TRANSMITTED FRAME : FECN=1 RECEIVED FRAME : BECN=1			
SECOND RESTRICTION			$\max RX \text{ t l X n 2} < SD \leq \max RX \text{ t l X n 3}$	TRANSMITTED FRAME DE=0:FECN=1 RECEIVED FRAME : BECN=1					
THIRD RESTRICTION			$\max RX \text{ t l X n 3} < SD \leq \max RX \text{ t l X n 4}$	TRANSMITTED FRAME DE=0:FECN=1 RECEIVED FRAME : BECN=1		TRANSMITTED FRAME DE=0:FECN=1 RECEIVED FRAME : BECN=1			
FOURTH RESTRICTION			$\max RX \text{ t l X n 4} < SD$	TRANSMITTED FRAME : DISCARD RECEIVED FRAME : BECN=1		TRANSMITTED FRAME : DISCARD RECEIVED FRAME : BECN=1		TRANSMITTED FRAME : DISCARD RECEIVED FRAME : BECN=1	

* SD: TRANSMISSION DATA QUANTITY,

** $0 < n1 < n2 < n3 < n4 \leq 1$

*** "DE=0:FECN=1" INDICATES THAT FECN=1 IS SET FOR FRAME OF DE=0

**** "DE=1:DISCARD" INDICATES THAT FRAME OF DE=1 IS DISCARDED

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled TRAFFIC CONTROL METHOD, NETWORK SYSTEM AND FRAME RELAY SWITCH

the specification of which

(check one) ☒ is attached hereto.

☐ was filed on _____ as

Application Serial No. _____

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
<u>8-285669</u>	<u>Japan</u>	<u>28/10/1996</u>	<u>(Yes)</u> No
(Number)	(Country)	(Day/Month/Year Filed)	
<u></u>	<u></u>	<u></u>	Yes No
(Number)	(Country)	(Day/Month/Year Filed)	
<u></u>	<u></u>	<u></u>	Yes No
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under Title 35, United State Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status - patented, pending, abandoned)
<u></u>	<u></u>	<u></u>
(Application Serial No.)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint as my attorney and agent Aaron B. Karas, Reg. No. 18,923, Samson Helfgott, Reg. No. 23,072 and Emma Shleifer, Reg. No. 29,734 to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Address all correspondence to: **HELFGOTT & KARAS P.C.**
60th Floor
Empire State Building
New York, New York 10118-0110
Telephone No. (212) 643-5000

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor Akitsugu Ohyoshi

Inventor's signature Akitsugu Ohyoshi Date May 22, 1997

Residence Kanagawa, Japan Citizenship Japan

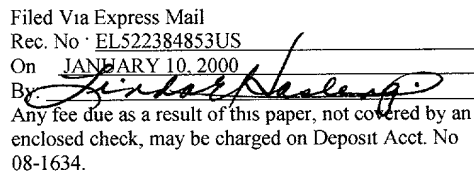
Post Office Address c/o Fujitsu Limited, 1-1, Kamikodanaka 4-chome, Nakahara-ku,
Kawasaki-shi, Kanagawa, 211 Japan

Full name of second joint inventor, if any Hiroshi Takahashi

Second Inventor's signature Hiroshi Takahashi Date May 22, 1997

Residence Kanagawa, Japan Citizenship Japan

Post Office Address c/o Fujitsu Limited, 1-1, Kamikodanaka 4-chome, Nakahara-ku,
Kawasaki-shi, Kanagawa, 211 Japan



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Assistant Commissioner for Patents
Washington, D. C. 20231

SUB-POWER OF ATTORNEY

I, Samson Helfgott, attorney of record herein, do hereby grant a sub-power of attorney to Linda S. Chan, Reg. No. 42,400; Jacqueline M. Steady, Reg. No. 44,354; and, Harris Wolin, Reg. No. 39,432 to act and sign in my behalf in the above-referenced application.

Respectfully submitted,

Samsen Helfgott
Reg. No. 23,072

HELFGOTT & KARAS, P.C.
EMPIRE STATE BUILDING
60TH FLOOR
NEW YORK, NEW YORK 10118
(212) 643-5000
DOCKET: FUJY 14.298
SH:JMS:lnda:FUJY14298PA

000110-10013450

Helfgott & Karas, P.C. (212)643-5000
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